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EXAMINER

HUISMAN, DAVID J

ART UNIT	PAPER NUMBER
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2183

DATE MAILED: 06/16/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/855,776

Applicant(s)

KUMAMOTO ET AL.

Examiner

David J. Huisman

Art Unit

2183

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 16 May 2001.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-28 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-28 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 16 May 2001 is/are: a) ☐ accepted or b) ☒ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
- 1) ☒ Certified copies of the priority documents have been received.
 - 2) ☐ Certified copies of the priority documents have been received in Application No. _____.
 - 3) ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|---|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

1. Claims 1-28 have been examined.

Specification

2. The abstract of the disclosure is objected to because of the following informalities:
Please remove the reference numbers in the abstract. Correction is required. See MPEP § 608.01(b).
3. The title of the invention is not descriptive. A new title is required that is clearly indicative of the invention to which the claims are directed.
4. The lengthy specification has not been checked to the extent necessary to determine the presence of all possible minor errors. Applicant's cooperation is requested in correcting any errors of which applicant may become aware in the specification.
5. The disclosure is objected to because of the following informalities: On page 22, in the first line of the last paragraph, replace "Fig. 10" with --Fig. 11--. On page 23, replace "oft he" with --of the--.

Appropriate correction is required.

Drawings

6. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they include the following reference sign(s) not mentioned in the description: In Fig.9, reference numbers 13c and 31c have not been found in the specification. In Fig.9, reference numbers 13c and 31c have not been found in the specification. In Fig.13, reference number 30e has not been

Art Unit: 2183

found in the specification. In Fig. 14, reference number 30f has not been found in the specification. In Fig. 16, reference numbers 10h, 11h, 13h, 14h, 31h, 33h, and 34h have not been found in the specification. In Fig. 18, reference numbers 12i, 13i, 15i, and 57 have not been found in the specification. A proposed drawing correction, corrected drawings, or amendment to the specification to add the reference sign(s) in the description, are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

Claim Objections

7. Claim 23 is objected to because of the following informalities: Please replace "cotrolled" with --controlled-- in line 4. Appropriate correction is required.

Claim Rejections - 35 USC § 112

8. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

9. Claim 5 recites the limitation "the series of instructions" in the third to last line. There is insufficient antecedent basis for this limitation in the claim since two series of instructions have been mentioned, the first being a series that is currently being executed by an arithmetic unit, and a second series that is being switched in for execution.

10. Claims 17 and 25 recite the limitation "said respective instruction decoders" in the last line. There is insufficient antecedent basis for this limitation in the claims. For purposes of this

Art Unit: 2183

examination, "said respective instruction decoders" will be interpreted as "said instruction decoder".

Claim Rejections - 35 USC § 102

11. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

12. Claims 1-6 and 8 are rejected under 35 U.S.C. 102(b) as being anticipated by Parady, U.S. Patent No. 5,933,627.

13. Referring to claim 1, Parady has taught a processor control apparatus for controlling a plurality of arithmetic units, said processor control apparatus comprising a plurality of instruction control units (Fig.5, components 150 and 154) for issuing a series of instructions to said plurality of arithmetic units (Fig.5, components 156, 160, 168, and 170), some of said instruction control units being operable to switch between a first execution process for driving said plurality of arithmetic units by means of a single series of instructions and a second execution process for driving said plurality of arithmetic units by means of a plurality of different series of instructions, respectively. See the abstract and note that while instructions belonging to a first execution process may be issued from a single instruction control unit, a long

Art Unit: 2183

latency event (or some other event) within that process will result in switching to driving arithmetic units using a second set of instructions belonging to a second execution process.

14. Referring to claim 2, Parady has taught a processor control apparatus as described in claim 1. Parady has further taught that said some instruction control units each perform a switching process for switching between said first execution process and said second execution process according to information which is contained in advance in a series of instructions. See the abstract, column 3, lines 57-64. Note that execution processes are switched due to multiple events such as a load instruction missing the data cache. The load instruction is contained in advance in a series of instructions. Also, other supported instructions are jumps to threads. See column 4, line 63, to column 5, line 5. These instructions are also considered information contained in advance in the series of instruction.

15. Referring to claim 3, Parady has taught a processor control apparatus as described in claim 1. Parady has further taught that when an M-th one of said instruction control units issues a second series of instructions to an N-th one of said arithmetic units which is performing said second execution process based on a first series of instructions issued by an N-th one of said instruction control units different from said M-th instruction control unit, said M-th instruction control unit is set in a wait state until said N-th arithmetic unit completes said second execution process. See column 4, lines 42-52, and note that if the second execution process is of highest priority (or at least higher priority than the process corresponding to the second series of instruction), then the M-th control unit will have to wait to issue instructions until the second execution process completes. Also, it should be realized that there are M instruction control

Art Unit: 2183

units (Fig.3, components 102-108, and Fig.5, components 154) and N functional units (Fig.1 and Fig.5).

16. Referring to claim 4, Parady has taught a processor control apparatus as described in claim 1. Parady has further taught a first storage element for holding a plurality of series of instructions, wherein when an M-th one of said instruction control units issues a second series of instructions to an N-th one of said arithmetic units which is performing said second execution process based on a first series of instructions issued by an N-th one of said instruction control units different from said M-th instruction control unit, said second series of instructions from said M-th instruction control unit are stored in said first storage element, and wherein said N-th arithmetic unit executes instructions which are stored in said first storage element based on information contained in said first series of instructions issued by said N-th instruction control unit. See Fig.3, for instance, and note the instruction control unit (say 104 in combination with 28), comprises a first storage element to hold thread instructions. If the thread 0 control unit (102 in combination with 28) issues a load that misses the cache or a jump to thread instruction, and the thread 1 control unit is the next to take control, then an Nth arithmetic unit will execute the instructions of thread 1 based on information contained in advance in the first series of instructions (i.e., the load or jump).

17. Referring to claim 5, Parady has taught a processor control apparatus as described in claim 1. Parady has further taught a second storage element which operates to hold, when one of said arithmetic units executing a series of instructions from one of said instruction control units is switched to execute a series of instructions from another instruction control unit, data generated by the series of instructions under execution by associating the data with that

Art Unit: 2183

instruction control unit which is executing the series of instructions. See Fig.3, components 48 and 50. Note that a register file exists for each thread to store data generated during execution of each thread, respectively.

18. Referring to claim 6, Parady has taught a processor control apparatus as described in claim 1. Parady has further taught that it is determined, based on an instruction executing state of each arithmetic unit, one of said arithmetic units to which a new series of instructions is to be issued by one of said instruction control units, and wherein said one instruction control unit is controlled based on the result of the determination so that the new series of instructions are directed to said one arithmetic unit thus determined. More specifically, when the arithmetic units are idle (for instance, in the case of a cache miss), a switch will occur, causing the new series of instructions to be directed to a particular (or more than one) arithmetic unit. For instance, if the thread 1 control unit is the next to issue instructions, and the instructions are all floating point multiplication instructions, then they will all be directed to the FP multiply unit 40 shown in Fig.1.

19. Referring to claim 8, Parady has taught a processor control apparatus as described in claim 1. Parady has further taught that each of said series of instructions includes a series of time sharing instructions for serially driving a plurality of ones of said arithmetic units. In one embodiment of Parady, threads are switched based on a round-robin counter (Fig.3, component 128), which is used to switch between threads at specified time intervals. In essence, the instructions in a series all share an amount of time before that thread (series) is switched out.

Art Unit: 2183

20. Claims 1-2 and 8-9 are rejected under 35 U.S.C. 102(e) as being anticipated by Fernando et al., U.S. Patent No. 6,272,616 (herein referred to as Fernando).

21. Referring to claim 1, Fernando has taught a processor control apparatus for controlling a plurality of arithmetic units (Fig. 1, components 24 and 26), said processor control apparatus comprising a plurality of instruction control units (Fig. 1) for issuing a series of instructions to said plurality of arithmetic units, some of said instruction control units being operable to switch between a first execution process for driving said plurality of arithmetic units by means of a single series of instructions and a second execution process for driving said plurality of arithmetic units by means of a plurality of different series of instructions, respectively. See Fig. 1 (notice multiplexer 21), and claim 44.

22. Referring to claim 2, Fernando has taught a processor control apparatus as described in claim 1. Fernando has further taught that said some instruction control units each perform a switching process for switching between said first execution process and said second execution process according to information which is contained in advance in a series of instructions. Note that the multiplexer 21 (Fig. 1) is what causes a switch in instruction stream execution. This switch is caused by a change in signal 32i, which is in response to an instruction (CFORK or DFORK) contained in advance in a first instruction stream. See column 5, lines 8-16.

23. Referring to claim 8, Fernando has taught a processor control apparatus as described in claim 1. Fernando has further taught that each of said series of instructions includes a series of time sharing instructions for serially driving a plurality of ones of said arithmetic units. For instance, looking at Fig. 7 of Fernando, the series of instructions corresponding to thread 2 execute from time 2 to time 7. Therefore, the thread takes 6 time units to execute and each

Art Unit: 2183

individual instruction requires some portion of the overall 6 time units for execution. Therefore, each instruction is a time sharing instruction, i.e., each instruction shares the overall 6 time units with the other instructions.

24. Referring to claim 9, Fernando has taught a processor control apparatus as described in claim 1. Fernando has further taught power control elements for controlling power supply to said arithmetic units based on their instruction executing states. See the abstract and column 8, lines 10-12, and note that unused processing elements are deactivated in order to conserve power.

Claim Rejections - 35 USC § 103

25. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

26. Claim 7 is rejected under 35 U.S.C. 103(a) as being unpatentable over Parady, as applied above, in view of Dowling, U.S. Patent No. 6,170,051.

27. Referring to claim 7, Parady has taught a processor control apparatus as described in claim 1. Parady has not taught that each of said series of instructions includes a VLIW type instruction. However, Dowling has taught series of instructions that comprise VLIW instructions. See the abstract. As is known in the art, and explained in column 1, lines 18-29, and lines 45-51, of Dowling, VLIW instructions allow for the utilization of multiple functional units in the same cycle, as opposed to just one per cycle. This (instruction level parallelism), in

Art Unit: 2183

turn, increases throughput. One of ordinary skill in the art would have recognized that VLIW instructions would be beneficial and implementable in Parady because Parady has taught multiple functional units, which when used in conjunction with VLIW instructions, would be utilized more efficiently in order to increase throughput. Consequently, it would have been obvious to one of ordinary skill in the art at the time of the invention to modify Parady to include VLIW instructions.

28. Claim 9 is rejected under 35 U.S.C. 103(a) as being unpatentable over Parady, as applied above, in view of Fernando, as applied above.

29. Referring to claim 9, Parady has taught a processor control apparatus as described in claim 1. Parady has not taught power control elements for controlling power supply to said arithmetic units based on their instruction executing states. However, Fernando has taught such a concept. See the abstract and column 8, lines 10-12. Note that when a particular functional unit is not in use, it will be powered down, thereby reducing the overall power consumption of the system. As is seen in Fig. 1 of Parady, many functional units exist which can execute instructions. A person of ordinary skill in the art would have recognized that by implementing the power-saving concept of Fernando into the system of Parady, power consumption would be reduced by powering down those functional units which are not in use. As a result, it would have been obvious to one of ordinary skill in the art at the time of the invention to modify Parady to include the powering mechanism taught by Fernando.

Art Unit: 2183

30. Claims 10-12, 15-17, 23-25, and 28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Fernando, as applied above.

31. Referring to claim 10, Fernando has taught a processor control apparatus comprising:

a) a single instruction memory for storing a plurality of series of instructions and supplying them to arithmetic units. See Fig. 1, components 12 and 26. Fernando has not taught a plurality of instruction memories for storing a plurality of series of instructions to be executed by a plurality of arithmetic units. However, Official Notice is taken that having a plurality of memories for storing independent series of instructions is well known and accepted in the art. In addition, as shown in Nerwin v. Erlichman, 168 USPQ 177 (1969), to make separable is generally not given patentable weight or would have been an obvious improvement. For instance, a person of ordinary skill in the art would have recognized that by implementing a plurality of memories instead of a single memory with concurrent access capabilities, as taught by Fernando (evident in Fig. 7 where multiple streams are fetched at once), then the circuitry required to allow for concurrent access would be eliminated, thereby reducing the complexity and cost of the system. Consequently, it would have been obvious to replace Fernando's single instruction memory with a plurality of instruction memories.

b) an instruction decoder for decoding a series of instructions from said instruction memories, and outputting a decoded result to any of said plurality of arithmetic units. See Fig. 1, component 22a, 22b, and 26.

c) and a selector for selectively switching between a plurality of series of instructions from said instruction memories to be decoded by said instruction decoder, and supplying a series of

Art Unit: 2183

instructions thus selected to said instruction decoder. See Fig.1, component 21, and claim 44 of Fernando.

32. Referring to claim 11, Fernando has taught a processor control apparatus as described in claim 10. Fernando has further taught that some of said plurality of series of instructions contain information about selective switching between said series of instructions to be performed by said selector, and wherein said instruction decoder decodes said information contained in a series of instructions, and outputs a switching instruction to said selector. See column 6, lines 41-54, and column 7, lines 17-29, and note that when a CFORK or DFORK is detected by decoder 22a, a signal 32i (Fig.1) is generated, which then causes the multiplexer 21 (Fig.1) to select another series of instructions, which will then be decoded.

33. Referring to claim 12, Fernando has taught a processor control apparatus as described in claim 10. Fernando has further taught that some of said plurality of series of instructions contain a synchronizing instruction for allowing a first predetermined one of said arithmetic units and a second predetermined arithmetic unit to synchronously perform processes, and wherein when said synchronizing instruction is issued to said first predetermined arithmetic unit, said first predetermined arithmetic unit is set in a wait state, and an instruction decoder of said second predetermined arithmetic unit does not output a switching instruction to its associated selector if a process is being executed by said second predetermined arithmetic unit upon issuance of said synchronizing instruction, and does not release the wait state of said first predetermined arithmetic unit until said second predetermined arithmetic unit completes said process. See column 7, lines 52-67. Note that a WAIT instruction will pause the first arithmetic unit until a DJOIN instruction is executed by the second arithmetic unit (synchronization). Furthermore, the

stream will not be switched as the second arithmetic unit will continue executing the same thread until it is finished (upon a DJOIN instruction). See Fig. 7.

34. Referring to claim 15, Fernando has taught a processor control apparatus as described in claim 10. Fernando has further taught that each of said series of instructions includes a series of time sharing instructions for serially driving a plurality of ones of said arithmetic units. For instance, looking at Fig. 7 of Fernando, the series of instructions corresponding to thread 2 execute from time 2 to time 7. Therefore, the thread takes 6 time units to execute and each individual instruction requires some portion of the overall 6 time units for execution. Therefore, each instruction is a time sharing instruction, i.e., each instruction shares the overall 6 time units with the other instructions.

35. Referring to claim 16, Fernando has taught a processor control apparatus as described in claim 10. Fernando has further taught power control elements for controlling power supply to said arithmetic units based on their instruction executing states. See the abstract and column 8, lines 10-12, and note that unused processing elements are deactivated in order to conserve power.

36. Referring to claim 17, Fernando has taught a processor control apparatus comprising:

- a) a single instruction memory for storing a plurality of series of instructions to be executed by a plurality of arithmetic units. See Fig. 1, components 12 and 26. Fig. 7 shows multiple series of instructions being executed by different units.
- b) an instruction decoder for decoding a series of instructions from said instruction memory, and outputting a decoded result to any of said plurality of arithmetic units. See Fig. 1, component 22a and 22b.

Art Unit: 2183

c) a selector for selectively switching between a plurality of series of instructions from said instruction memory to be decoded by said instruction decoder, and supplying a series of instructions thus selected to said instruction decoder. See Fig. 1, component 21, and claim 44 of Fernando.

d) wherein said instruction memory has a plurality of ports for issuing said series of instructions to said instruction decoder. See Fig. 1 component 12 and note that multiple ports are connected to multiple fetch units and ultimately to multiple decoders.

37. Referring to claim 23, Fernando has taught a processor comprising:

a) a plurality of arithmetic units. See Fig. 1, components 24a, 24b, and 26.

b) a plurality of instruction control units for issuing a series of instructions to drive said arithmetic units in a controlled manner. See Fig. 1 and note a first instruction control unit would comprise at least components 20a, 22a, and 12, whereas a second unit would comprise at least components 20b, 22b, and 12. Each of these units issues instructions to the arithmetic units.

c) wherein some of said instruction control units are operable to switch between a first execution process for driving said plurality of arithmetic units by means of a single series of instructions and a second execution process for driving said plurality of arithmetic units by means of a plurality of different series of instructions, respectively. See Fig. 1, component 21 and claim 44.

Note that the MUX can either select a first series of instruction from bus 36 or a second series from bus 35.

38. Referring to claim 24, Fernando has taught a processor comprising:

a) a plurality of arithmetic units. See Fig. 1, components 24 and 26.

Art Unit: 2183

b) a single instruction memory for storing a plurality of series of instructions and supplying them to arithmetic units. See Fig.1, components 12. Fernando has not taught a plurality of instruction memories for storing a plurality of series of instructions to be executed by a plurality of arithmetic units. However, Official Notice is taken that having a plurality of memories for storing independent series of instructions is well known and accepted in the art. In addition, as shown in Nerwin v. Erlichman, 168 USPQ 177 (1969), to make separable is generally not given patentable weight or would have been an obvious improvement. For instance, a person of ordinary skill in the art would have recognized that by implementing a plurality of memories instead of a single memory with concurrent access capabilities, as taught by Fernando (evident in Fig.7 where multiple streams are fetched at once), then the circuitry required to allow for concurrent access would be eliminated, thereby reducing the complexity and cost of the system. Consequently, it would have been obvious to replace Fernando's single instruction memory with a plurality of instruction memories.

c) an instruction decoder for decoding a series of instructions from said instruction memories, and outputting a decoded result to any of said plurality of arithmetic units. See Fig.1, component 22a and 22b.

d) and a selector for selectively switching between a plurality of series of instructions from said instruction memories to be decoded by said instruction decoder, and supplying a series of instructions thus selected to said instruction decoder. See Fig.1, component 21, and claim 44 of Fernando. Note that the MUX can either select a first series of instruction from bus 36 or a second series from bus 35.

39. Referring to claim 25, Fernando has taught a processor comprising:

Art Unit: 2183

- a) a plurality of arithmetic units. See Fig. 1, components 24 and 26.
- b) a single instruction memory for storing a plurality of series of instructions to be executed by a plurality of arithmetic units. See Fig. 1, components 12 and 26. Fig. 7 shows multiple series of instructions being executed by different units.
- c) an instruction decoder for decoding a series of instructions from said instruction memory, and outputting a decoded result to any of said plurality of arithmetic units. See Fig. 1, component 22a and 22b.
- d) a selector for selectively switching between a plurality of series of instructions from said instruction memory to be decoded by said instruction decoder, and supplying a series of instructions thus selected to said instruction decoder. See Fig. 1, component 21, and claim 44 of Fernando.
- e) wherein said instruction memory has a plurality of ports for issuing said series of instructions to said instruction decoder. See Fig. 1 component 12 and note that multiple ports are connected to multiple fetch units and ultimately to multiple decoders.

40. Referring to claim 28, Fernando has taught a processor controlling method usable with a plurality of instruction control units for controlling a plurality of arithmetic units to execute a plurality of series of instructions, said method comprising the steps of:

- a) prescribing, in advance in a series of instructions which is to be performed, synchronous execution in which a plurality of predetermined ones of said arithmetic units are synchronously driven by a single series of instructions, or independent execution in which the plurality of predetermined arithmetic units are independently driven by a plurality of respective series of instructions. A single series of instructions may be used to drive a plurality of arithmetic units.

Art Unit: 2183

This would occur when the selector 21 shown in Fig. 1 selects the instructions from bus 36. This corresponds to Fig. 7 at times 10-12 when a single series of instruction (thread 1) is executed by two different data paths (arithmetic units), and hence results in the "combined control" illustrated in the figure. On the other hand, independent execution of a plurality of series of instructions by a plurality of arithmetic units is also shown in Fig. 7. For instance, two series (corresponding to thread 1 and 2) are independently executed by data paths 1 and 2 (arithmetic units). This would occur when MUX 21 in Fig. 1 selects the group of instructions from bus 35.

b) switching between the predetermined arithmetic units for performing a series of instructions based on the contents of the prescription therein. Clearly from the examples given in Fig. 7, synchronous execution of a single series or independent execution of multiple series of instructions is switched back and forth. See Fig. 7, and notice data paths 1 and 2 from time 1-12.

41. Claim 13 is rejected under 35 U.S.C. 103(a) as being unpatentable over Fernando, as applied above, in view of Parady, as applied above.

42. Referring to claim 13, Fernando has taught a processor control apparatus as described in claim 10.

a) Fernando has not explicitly taught an instruction queue for temporarily storing, at a stage prior to said selector, a series of instructions to be transmitted from a second one of said instruction memories different from a first one of said instruction memories which stores a series of instructions being executed by said first predetermined arithmetic unit. However, Parady has taught employing multiple instruction queues for holding different series of instructions before one of them is selected. See Fig. 3, components 102-108. A person of ordinary skill in the art

Art Unit: 2183

would have recognized that an instruction queue allows a system to hold a series of instructions within the system. Instructions from the queue will be retrieved faster than if they had to be retrieved from main memory since main memory is slower than an on-chip memory, such as Parady's queues. Consequently, it would have been obvious to one of ordinary skill in the art at the time of the invention to modify Fernando to include instruction queues on-chip to hold series of instruction so that the instructions are retrieved faster than they would from main memory.

b) and a determiner for determining, based on a series of instructions being executed, whether or not the process being performed by said first predetermined arithmetic unit can be interrupted, said determiner operating to output, if the process can be interrupted, an interrupt signal for interrupting the issuance of the series of instructions to said first instruction memory which is a source of the series of instructions being executed, and generate a switching instruction to said selector to switch to a series of instructions from said instruction queue. Looking at Fig. 1, it should be realized that if the first arithmetic unit 24b is executing a stream of instructions from bus 36 and a DFORK instruction is encountered by decoder 22a, then the MUX for the first arithmetic unit will be configured such that the execution of a first stream of instructions is interrupted in order to execute a second stream of instructions from bus 35. See column 5, lines 17-25, and column 7, lines 17-29. So, in essence, Fernando has taught interrupting a first process in order to execute a second process.

43. Claims 14, 18-22, and 26-27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Fernando, as applied above, in view of Dowling, as applied above.

Art Unit: 2183

44. Referring to claim 14, Fernando has taught a processor control apparatus as described in claim 10. Fernando has not taught that each of said series of instructions includes a VLIW type instruction. However, Dowling has taught series of instructions that comprise VLIW instructions. See the abstract. As is known in the art, and explained in column 1, lines 18-29, and lines 45-51, of Dowling, VLIW instructions allow for the utilization of multiple functional units in the same cycle, as opposed to just one per cycle. This (instruction level parallelism), in turn, increases throughput. One of ordinary skill in the art would have recognized that VLIW instructions would be beneficial and implementable in Fernando because Fernando has taught multiple functional units (Fig. 1, components 26), which when used in conjunction with VLIW instructions, would be utilized more efficiently in order to increase throughput. Consequently, it would have been obvious to one of ordinary skill in the art at the time of the invention to modify Fernando to include VLIW instructions.

45. Referring to claim 18, Fernando has taught a processor control apparatus for controlling a plurality of arithmetic units (Fig. 1, components 24a and 24b), said processor control apparatus comprising a plurality of instruction control units for instructing said arithmetic units to execute a series of instructions, wherein each of said instruction control units includes:

a) a single instruction memory for storing a plurality of series of instructions and supplying them to arithmetic units. See Fig. 1, components 12 and 26. Fernando has not taught that each instruction control unit includes an instruction memory for storing a plurality of series of instructions, i.e. a plurality of instruction memories. However, Official Notice is taken that having a plurality of memories for storing series of instructions is well known and accepted in the art. In addition, as shown in Nerwin v. Erlichman, 168 USPQ 177 (1969), to make separable

Art Unit: 2183

is generally not given patentable weight or would have been an obvious improvement. For instance, a person of ordinary skill in the art would have recognized that by implementing a plurality of memories instead of a single memory with concurrent access capabilities, as taught by Fernando (evident in Fig. 7 where multiple streams are fetched at once), then the circuitry required to allow for concurrent access would be eliminated, thereby reducing the complexity and cost of the system. Consequently, it would have been obvious to replace Fernando's single instruction memory with a plurality of instruction memories.

b) an instruction decoder for decoding a series of instructions and supplying the decoded series of instructions to an associated one of said arithmetic units. See Fig. 1, components 22a and 22b (note that the control units may each comprise at least a decoder, fetch unit, and instruction memory).

c) wherein some of said instruction control units each have an instruction control selector for selectively switching between a first series of instructions from a first instruction memory of one of said instruction control units and a second series of instructions from a second instruction memory of another instruction control unit different from said one instruction control unit to output one of said first and second series of instructions thus selected to said instruction decoder. See Fig. 1, component 21 and note that either a first series of instructions along bus 36 may be selected for decoding or a second series of instructions from bus 35 may be selected for decoding.

d) wherein each of said arithmetic units includes a register file (say 25b) for storing data during execution and the ability to access the register file of another arithmetic unit (25a) via bus 38 by using MOVE instructions. See column 6, lines 16-32. Fernando has not taught that each

Art Unit: 2183

arithmetic unit includes a first register file and a second register file for storing data generated by said first and second series of instructions, respectively, which are supplied from said first and second instruction memories and decoded by an instruction decoder of an associated one of said instruction control units, and an arithmetic unit selector for selectively switching between said data generated by said first and second series of instructions being executed and stored in said first and second register files, respectively, according to an instruction from said associated instruction decoder to supply a selected one of said first and second series of instructions to a calculator.. However, Dowling has taught such a concept. Note from Fig.2, that arithmetic unit 200 includes two register sets 160 and 260 for use in executing two different instruction streams 130 and 230. Based on the stream, one of the register sets is selected by selector 290. By adding a second set of registers to the arithmetic unit, according to column 9, lines 59-62, the processing hardware can quickly switch both internal context and external context, i.e. quickly switch execution from one stream of instructions to another, as Fernando has taught. A person of ordinary skill in the art would have also recognized that by having a second register set in an arithmetic unit, the MOVE instruction would not be required to move data from one set to another in order to facilitate execution of another stream. This would also reduce the complexity of the system. Therefore, in order to speed up the system and reduce complexity, it would have been obvious to one of ordinary skill in the art at the time of the invention to modify Fernando such that each arithmetic unit includes a second register set.

46. Referring to claim 19, Fernando in view of Dowling has taught a processor control apparatus as described in claim 18. Fernando has not taught that each of said series of instructions includes a VLIW type instruction. However, Dowling has taught series of

Art Unit: 2183

instructions that comprise VLIW instructions. See the abstract. As is known in the art, and explained in column 1, lines 18-29, and lines 45-51, of Dowling, VLIW instructions allow for the utilization of multiple functional units in the same cycle, as opposed to just one per cycle. This (instruction level parallelism), in turn, increases throughput. One of ordinary skill in the art would have recognized that VLIW instructions would be beneficial and implementable in Fernando because Fernando has taught multiple functional units, which when used in conjunction with VLIW instructions, would be utilized more efficiently in order to increase throughput. Consequently, it would have been obvious to one of ordinary skill in the art at the time of the invention to modify Fernando to include VLIW instructions.

47. Referring to claim 20, Fernando in view of Dowling has taught a processor control apparatus as described in claim 18. Fernando has further taught that each of said series of instructions includes a series of time sharing instructions for serially driving a plurality of ones of said arithmetic units. For instance, looking at Fig. 7 of Fernando, the series of instructions corresponding to thread 2 execute from time 2 to time 7. Therefore, the thread takes 6 time units to execute and each individual instruction requires some portion of the overall 6 time units for execution. Therefore, each instruction is a time sharing instruction, i.e., each instruction shares the overall 6 time units with the other instructions.

48. Referring to claim 21, Fernando in view of Dowling has taught a processor control apparatus as described in claim 18. Fernando has further taught power control elements for controlling power supply to said arithmetic units based on their instruction executing states. See the abstract and column 8, lines 10-12, and note that unused processing elements are deactivated in order to conserve power.

Art Unit: 2183

49. Referring to claim 22, Fernando has taught a processor control apparatus for controlling a plurality of arithmetic units (Fig. 1, components 24 and 26), said processor control apparatus comprising a plurality of instruction control units (Fig. 1) for instructing said arithmetic units to execute a series of instructions.

a) wherein said instruction control units have a single instruction memory used in common for storing a plurality of series of instructions (see Fig. 1, component 12), and each includes an instruction decoder for decoding a series of instructions and supplying the decoded series of instructions to an associated one of said arithmetic units (see Fig. 1, components 22a and 22b, and note that the control units may each comprise at least a decoder, fetch unit, and instruction memory), and said single instruction memory has a plurality of ports for issuing said series of instructions to said respective instruction decoders (See Fig. 1 component 12 and note that multiple ports are connected to multiple fetch units and ultimately to multiple decoders).

b) wherein some of said instruction control units each have an instruction control selector for selectively switching between a first series of instructions from a first instruction memory of one of said instruction control units and a second series of instructions from a second instruction memory of another instruction control unit different from said one instruction control unit to output one of said first and second series of instructions thus selected to said instruction decoder. See Fig. 1, component 21 and note that either a first series of instructions along bus 36 may be selected for decoding or a second series of instructions from bus 35 may be selected for decoding.

c) wherein each of said arithmetic units includes a register file (say 25b) for storing data during execution and the ability to access the register file of another arithmetic unit (25a) via bus 38 by

Art Unit: 2183

using MOVE instructions. See column 6, lines 16-32. Fernando has not taught that each arithmetic unit includes a first register file and a second register file for storing data generated by said first and second series of instructions, respectively, which are supplied from said first and second instruction memories and decoded by an instruction decoder of an associated one of said instruction control units, and an arithmetic unit selector for selectively switching between said data generated by said first and second series of instructions being executed and stored in said first and second register files, respectively, according to an instruction from said associated instruction decoder to supply a selected one of said first and second series of instructions to a calculator.. However, Dowling has taught such a concept. Note from Fig. 2, that arithmetic unit 200 includes two register sets 160 and 260 for use in executing two different instruction streams 130 and 230. Based on the stream, one of the register sets is selected by selector 290. By adding a second set of registers to the arithmetic unit, according to column 9, lines 59-62, the processing hardware can quickly switch both internal context and external context, i.e. quickly switch execution from one stream of instructions to another, as Fernando has taught. A person of ordinary skill in the art would have also recognized that by having a second register set in an arithmetic unit, the MOVE instruction would not be required to move data from one set to another in order to facilitate execution of another stream. This would also reduce the complexity of the system. Therefore, in order to speed up the system and reduce complexity, it would have been obvious to one of ordinary skill in the art at the time of the invention to modify Fernando such that each arithmetic unit includes a second register set.

50. Referring to claim 26, Fernando has taught a processor comprising:

a) a plurality of arithmetic units (Fig. 1, components 24 and 26).

Art Unit: 2183

b) a plurality of instruction control units (Fig. 1) for driving said arithmetic units in a controlled manner, wherein each of said instruction control units includes:

c) a single instruction memory for storing a plurality of series of instructions and supplying them to arithmetic units. See Fig. 1, components 12 and 26. Fernando has not taught that each instruction control unit includes an instruction memory for storing a plurality of series of instructions, i.e. a plurality of instruction memories. However, Official Notice is taken that having a plurality of memories for storing series of instructions is well known and accepted in the art. In addition, as shown in Nerwin v. Erlichman, 168 USPQ 177 (1969), to make separable is generally not given patentable weight or would have been an obvious improvement. For instance, a person of ordinary skill in the art would have recognized that by implementing a plurality of memories instead of a single memory with concurrent access capabilities, as taught by Fernando (evident in Fig. 7 where multiple streams are fetched at once), then the circuitry required to allow for concurrent access would be eliminated, thereby reducing the complexity and cost of the system. Consequently, it would have been obvious to replace Fernando's single instruction memory with a plurality of instruction memories.

d) an instruction decoder for decoding a series of instructions and supplying the decoded series of instructions to an associated one of said arithmetic units. See Fig. 1, components 22a and 22b (note that the control units may each comprise at least a decoder, fetch unit, and instruction memory).

e) wherein some of said instruction control units each have an instruction control selector for selectively switching between a first series of instructions from a first instruction memory of one of said instruction control units and a second series of instructions from a second instruction

Art Unit: 2183

memory of another instruction control unit different from said one instruction control unit to output one of said first and second series of instructions thus selected to said instruction decoder.

See Fig. 1, component 21 and note that either a first series of instructions along bus 36 may be selected for decoding or a second series of instructions from bus 35 may be selected for decoding.

f) wherein each of said arithmetic units includes a register file (say 25b) for storing data during execution and the ability to access the register file of another arithmetic unit (25a) via bus 38 by using MOVE instructions. See column 6, lines 16-32. Fernando has not taught that each arithmetic unit includes a first register file and a second register file for storing data generated by said first and second series of instructions, respectively, which are supplied from said first and second instruction memories and decoded by an instruction decoder of an associated one of said instruction control units, and an arithmetic unit selector for selectively switching between said data generated by said first and second series of instructions being executed and stored in said first and second register files, respectively, according to an instruction from said associated instruction decoder to supply a selected one of said first and second series of instructions to a calculator.. However, Dowling has taught such a concept. Note from Fig. 2, that arithmetic unit 200 includes two register sets 160 and 260 for use in executing two different instruction streams 130 and 230. Based on the stream, one of the register sets is selected by selector 290. By adding a second set of registers to the arithmetic unit, according to column 9, lines 59-62, the processing hardware can quickly switch both internal context and external context, i.e. quickly switch execution from one stream of instructions to another, as Fernando has taught. A person of ordinary skill in the art would have also recognized that by having a second register set in an

Art Unit: 2183

arithmetic unit, the MOVE instruction would not be required to move data from one set to another in order to facilitate execution of another stream. This would also reduce the complexity of the system. Therefore, in order to speed up the system and reduce complexity, it would have been obvious to one of ordinary skill in the art at the time of the invention to modify Fernando such that each arithmetic unit includes a second register set.

51. Referring to claim 27, Fernando has taught a processor comprising:

- a) a plurality of arithmetic units (Fig. 1, components 24 and 26).
- b) a plurality of instruction control units (Fig. 1) for driving said arithmetic units in a controlled manner.
- c) wherein said instruction control units have a single instruction memory used in common for storing a plurality of series of instructions (see Fig. 1, component 12), and each includes an instruction decoder for decoding a series of instructions and supplying the decoded series of instructions to an associated one of said arithmetic units (see Fig. 1, components 22a and 22b, and note that the control units may each comprise at least a decoder, fetch unit, and instruction memory), and said single instruction memory has a plurality of ports for issuing said series of instructions to said respective instruction decoders (See Fig. 1 component 12 and note that multiple ports are connected to multiple fetch units and ultimately to multiple decoders).
- e) wherein some of said instruction control units each have an instruction control selector for selectively switching between a first series of instructions from a first instruction memory of one of said instruction control units and a second series of instructions from a second instruction memory of another instruction control unit different from said one instruction control unit to output one of said first and second series of instructions thus selected to said instruction decoder.

Art Unit: 2183

See Fig. 1, component 21 and note that either a first series of instructions along bus 36 may be selected for decoding or a second series of instructions from bus 35 may be selected for decoding.

f) wherein each of said arithmetic units includes a register file (say 25b) for storing data during execution and the ability to access the register file of another arithmetic unit (25a) via bus 38 by using MOVE instructions. See column 6, lines 16-32. Fernando has not taught that each arithmetic unit includes a first register file and a second register file for storing data generated by said first and second series of instructions, respectively, which are supplied from said first and second instruction memories and decoded by an instruction decoder of an associated one of said instruction control units, and an arithmetic unit selector for selectively switching between said data generated by said first and second series of instructions being executed and stored in said first and second register files, respectively, according to an instruction from said associated instruction decoder to supply a selected one of said first and second series of instructions to a calculator.. However, Dowling has taught such a concept. Note from Fig. 2, that arithmetic unit 200 includes two register sets 160 and 260 for use in executing two different instruction streams 130 and 230. Based on the stream, one of the register sets is selected by selector 290. By adding a second set of registers to the arithmetic unit, according to column 9, lines 59-62, the processing hardware can quickly switch both internal context and external context, i.e. quickly switch execution from one stream of instructions to another, as Fernando has taught. A person of ordinary skill in the art would have also recognized that by having a second register set in an arithmetic unit, the MOVE instruction would not be required to move data from one set to another in order to facilitate execution of another stream. This would also reduce the complexity

Art Unit: 2183

of the system. Therefore, in order to speed up the system and reduce complexity, it would have been obvious to one of ordinary skill in the art at the time of the invention to modify Fernando such that each arithmetic unit includes a second register set.

Conclusion

52. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Applicant is reminded that in amending in response to a rejection of claims, the patentable novelty must be clearly shown in view of the state of the art disclosed by the references cited and the objections made. Applicant must also show how the amendments avoid such references and objections. See 37 CFR § 1.111(c).

Vishkin, U.S. Patent No. 6,463,527, has taught a spawn-join instruction set architecture for providing explicit multithreading. Vishkin has shown multiple thread control units, registers for each thread, and multiple dispatch units which are able to dispatch instructions to a number of functional units.

Kimura et al., U.S. Patent No. 5,546,593, has taught a multistream instruction processor able to reduce interlocks by having a wait state for an instruction stream. Kimura has also taught that multiple functional units are able to receive instructions from different streams.

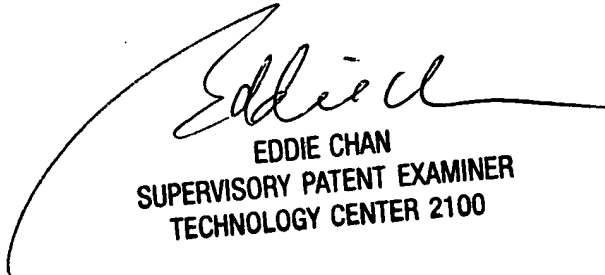
Any inquiry concerning this communication or earlier communications from the examiner should be directed to David J. Huisman whose telephone number is (703) 305-7811. The examiner can normally be reached on Monday-Friday (8:00-4:30).

Art Unit: 2183

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Eddie Chan can be reached on (703) 305-9712. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

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David J. Huisman
June 10, 2004



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